

# Using Business Management Flight Simulators as a Teaching Tool for Entrepreneurs

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**Abstract – Decision-making in entrepreneurship is often very risky because consequences of entrepreneurs' actions are visible only after longer time (months or even years). Ideal education tool in entrepreneurship would allow entrepreneurs to compresses time and space in non-risk environment and to gain experience and make mistakes without fear of real damage. Such tool would allow potential entrepreneurs to see the consequences of his/her actions in few minutes or hours, and to detect possible wrong presumptions about the real world venture capitalism. This paper argues that management flight simulation models could meet the educational challenge in entrepreneurship and allow entrepreneurs to avoid intuitively correct decisions that are actually not optimal. Paper will present the system dynamics model of supply and demand.**

## I. INTRODUCTION

Decision-making in entrepreneurship is very complicated because costs of managers' decisions are visible only after longer time. For example, if new product is released it will take some time until it becomes accepted from the customer base. In addition, acceptance of new products industry is influenced to the great extent by the many factors. Some of them are relative price of the product compared to similar products, substitute products, attractiveness of marketing campaign compared to competitive products, sales – promotion, word of mouth, friendly salesman, etc.

Entrepreneurs would benefit from more effective education that would improve the quality of the decisions making. The purpose of this article is to describe and demonstrate applicability of system dynamics models as decision and learning support tools for entrepreneurship organizations that permit controlled experimentation and enhance understanding of reality.

## II. USING SYSTEM DYNAMIC MODELS AS MANAGEMENT LEARNING TOOLS

System dynamics is a powerful tool that enhances learning about company, market and competitors, portrays the cognitive limitations on the information gathering and processing power of human mind, facilitates the practice of considering opinions, and supports building of "What if" scenarios.

Over the past thirty years, the growth of computer technology has facilitated the wide application of system dynamics modeling as sophisticated tools for simulating

business environments and situations. The basic goal of management simulation games is to apply experiential learning to the commercial world. They are designed in order to allow the player to experiment with the model on a compressed time basis while reducing costs and personal risk. The participant is able to see the consequences of his/her actions in few minutes or hours. In real world such consequences are visible only after much longer time (months or years).

In order to achieve educational objectives, simulation should start with adequate briefing, which introduces the rules of the game and helps the players to vividly imagine themselves in described situation. Learning objective of the game should be clearly defined. For example, one of the learning objectives of Fish Bank Ltd. is to show how competitive behavior can destroy renewable resources (Meadows, 1989). Simulation games are equipped with different technology that could include game boards, sheets to contain with decisions or computer-based system dynamics models. Duration of play could be hours, or could be few minutes and different number of players could be involved. Important part of the game is debriefing, which helps players to construct their experience into knowledge that can be re-applied.

It seems that simulation games are very useful in helping players to learn, but according to the opinion of several authors there is still present a doubt that knowledge acquired can be applied in real work situation (Summers, 2004; Zapalaska et al. , 2008). The real payoff from simulation games can be achieved if attention is paid to number of possible difficulties and problems: (1) no clarity regarding learning objectives, (2) materials support an event without learning, (3) neglect of other teaching methods, (4) inappropriate emphasis on technology, (5) too many elements mixed, (6) inadequate briefing, (7) inadequate debrief, (8) offering operators too little training, and (9) under-estimating time and money needed to create materials.

There are numerous management games with high potential for application in entrepreneurship, and some of them will be described.

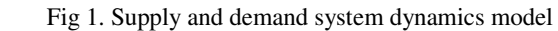
People Express Airlines was established in 1981. In only five years the company had grown to be the fifth largest airline in the United States (Serman, 2001). Yet by September of 1986, People Express was nearly bankrupt, and was acquired at the last minute by Texas Air. The People Express Management Flight Simulator gives the

Beer distribution game, originally called the “production-distribution game”, is played on a board that portrays the production and distribution of beer. Each team consists of four sectors: Retailer, Wholesaler, Distributor and Factory arranged in a linear distribution chain. The goal of the game is to meet customer demand and order enough from your supplier to keep your inventory low while avoiding costly backlogs (Sterman, 1992).

Professional Services Microworld will be described in detail (Strategy dynamics, 2001). The game is designed in order to experience the challenges of a professional service organisation named the Partner team with the aim to grow the business in size and reputation over 30 years, creating wealth for the firm's partners. In order to achieve this objective, player will try to manage the growth of professional staff (consultants, assignment managers and partners) to match growth of the client-base.

Last year I taught Economics and I tried to explain relation between supply, demand and price. Somebody asked me what is the practical use of the analysis of the demand and supply curves, and in few moments whole class was discussing how equilibrium price is determined. Our intuitive answer was that supply and demand curves are useful in long term. The reason is that when supply or demand changes equilibrium price is disturbed, and oscillations occur. For example, when demand is higher than supply, price will increase. But, producers will react and produce more goods that will increase supply more than demand. Customer will not buy all the products offered on the market and excess supply will again lower the price. But, we could not agree on how equilibrium price will be again achieved because we were discussing supply as if it is determined with production, and we did not take into account inventory. Finally, we have agreed that equilibrium price is achieved only in long term, and that in short term price, demand and supply oscillate around it. If we had system dynamics model presented in the paper we could confirm our hypothesis and enhance our analysis by taking inventory into account. Effective decision-making contributes to better performance of

### A. Supply and demand system dynamics model



- **positive feedback loop 1** – As Price increases, change in price also increases, which in turn increases Price.
- **positive feedback loop 2** – As Price increases, desired price increases, which increases change in Price and finally Price increases.
- **negative feedback loop 1** – As Price increases, price ratio increases, which increases effect of price on supply. This is the reason why supply increases, which also increases Inventory. As Inventory increases, inventory ratio also increases, effect of inventory on price decreases, which decrease desired price and change in price. Finally, Price decreases.
- **negative feedback loop 2** – As Price increases, price ratio increases, which decreases effect of price on demand. Therefore, demand decreases, which is the reason why desired inventory decreases. As desired inventory decreases, inventory ratio increases, which decreases effect of inventory on price and desired price also decreases. Finally, Price decreases.
- **negative feedback loop 3** – Increase in Price increases price ratio which decreases effect of price on demand. This is the reason why demand decreases, which decreases shipments. Inventory and inventory ratio increase. Therefore effect of inventory on price decreases, which decreases

desired price and change in price. Finally, Price decreases.

### B. Model equations

In this part of the paper model equations will be presented. Equations are automatically generated by the software Vensim that has been used for designing the model for supply and demand.

change in price=(desired price-Price)/PRICE CHANGE DELAY

Units: \$/shirt/Week

Change in price is determined by the difference between desired price and current price and number of weeks needed to change the price.

demand=NORMAL DEMAND\*effect of price on demand

Units: shirt/Week

This is the rate at which consumers wish to purchase clothing from the suppliers.

desired inventory=demand\*DESIRED INVENTORY COVERAGE

Units: shirt

Desired inventory is how much inventory the suppliers would like to have. It is calculated as how many weeks worth of demand they would like to store in inventory.

DESIRED INVENTORY COVERAGE=4

Units: Week

Number of weeks of demand that suppliers would like to keep in inventory.

desired price=effect of inventory on price\*Price

Units: \$/shirt

This is the equilibrium price as set by the inventory ratio. The actual price will reach this value after a delay specified by the price change delay.

effect of inventory on price=effect of inventory on price lookup(inventory ratio)

Units: dmnl

When the ratio of inventory to desired inventory is greater than 1 price increases, an opposite.

effect of inventory on price lookup

([(0.5,0)-(1.5,2)],(0.5,2),(0.6,1.8),(0.7,1.55),(0.8,1.35),(0.9,1.15),(1,1),(1.1,0.875),(1.2,0.75),(1.3,0.65),(1.4,0.55),(1.5,0.5))

Units: dmnl

Lookup function for the effect of inventory on price.

effect of price on demand=effect of price on demand lookup(price ratio)

Units: dmnl

Demand for shirts depends on price of the product. When the price is higher, demand is lower and opposite.

effect of price on demand lookup

([(0,0)-(4,2.5)],(0,2.5),(0.33,1.754),(0.67,1.281),(1,1),(1.33,0.789),(1.67,0.614),(2,0.491),(2.33,0.386),(2.67,0.316),(3,0.246),(3.33,0.175),(4,0.175))

Units: dmnl

Lookup function for effect of price on demand.

effect of price on supply=

effect of price on supply lookup(price ratio)

Units: dmnl

Supply of shirts depends on price. When price is higher, more shirts are produced, and opposite.

effect of price on supply lookup

([(0,0)-(4,2)],(0,0),(0.33,0),(0.67,0.702),(1,1),(1.33,1.193),(1.67,1.351),(2,1.474),(2.33,1.561),(2.67,1.649),(3,1.702),(3.33,1.754),(4,1.754))

Units: dmnl

Lookup function for the effect of price on supply.

INITIAL PRICE=15

Units: \$/shirt

Initial price at which consumers were willing to buy number of shirts equal to normal demand, and firms were willing to produce number of shirts equal to normal supply.

Inventory= INTEG (+supply-shipments, desired inventory)

Units: shirt

Inventory is the stock of produced clothing in the company's warehouse.

inventory ratio=Inventory/desired inventory

Units: dmnl

Ratio of inventory to desired inventory.

NORMAL DEMAND=57

Units: shirt/Week

Number of shirts that consumers are willing to purchase at initial price.

NORMAL SUPPLY=57

Units: shirt/Week

Number of shirts that firms are willing to produce at initial price.

Price= INTEG (change in price,INITIAL PRICE)

Units: \$/shirt

Current price of shirts in the market.

price change delay=15

Units: Week

Number of weeks at which price changes to desired price.

price ratio=Price/INITIAL PRICE

Units: dmnl

Ratio of price to initial price.

shipments=demand

Units: shirt/Week

Number of shirts shipped per week is equal to the demand.

supply=effect of price on supply\*NORMAL SUPPLY

Units: shirt/Week

Number of shirts produced each week.

### C. Lookup functions

Lookup functions explain the relation between two variables that are nonlinear. On Fig.2. there is a relation between inventory and price, which indicates the lower price in case of higher inventory. On Fig.3. there is a relation between price and demand, which indicates the higher price in case of higher demand. On Fig. 4. there is a relation between price and supply, which indicates the lower price in case of higher supply.

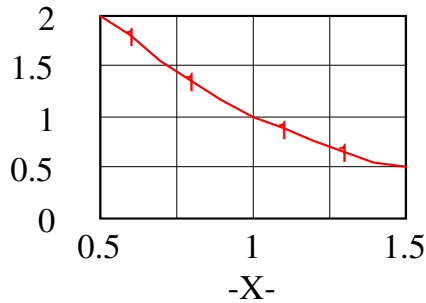


Fig. 2. Effect of inventory on price lookup

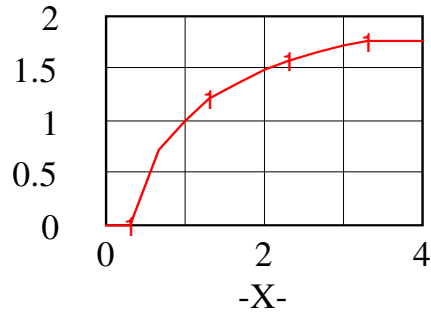


Fig. 3. Effect of price on demand lookup

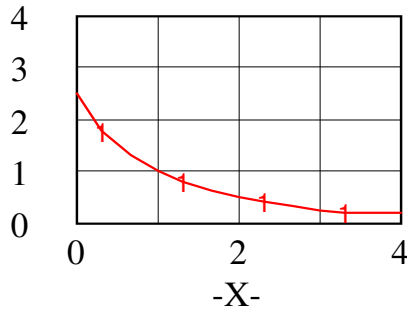


Fig.4. Effect of price on supply lookup

### D. Experiments with the model

In this part of the paper experiments with the model will be presented in case of four scenarios: (1) increase in demand, (2) different values of desired inventory coverage, (3) different values of price change delay, and (4) damped and sustained oscillations.

#### • Increase in Demand

If we want the system to be in equilibrium inventory should be 228 shirts. Initial price is 15\$, and at that price demand is equal to supply which are 57 shirts. Desired inventory coverage is 4 weeks, and therefore inventory should be 228 shirts. Price change delay does not have any effect on value of inventory needed for equilibrium.

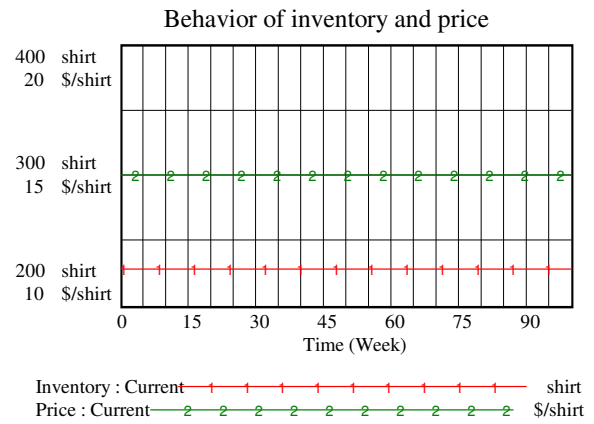


Fig. 5. Behavior of inventory and price in equilibrium

If demand increases permanently for 10 articles per week, new equilibrium value for price is 16.97, and equilibrium value for demand is 61.36 shirts per week. Therefore, equilibrium value for inventory is 245.44 shirts, and it is four times larger than demand because desired inventory coverage is still 4 weeks. Before inventory reaches equilibrium value it will exhibit sustained oscillations.

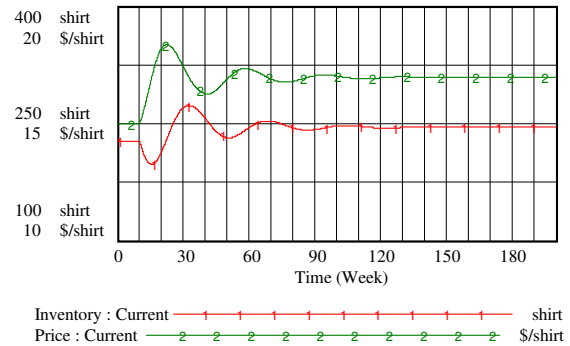


Fig.6. Behavior of inventory and price after increase in demand

- **Desired Inventory Coverage**

Value of desired inventory coverage influences inventory equilibrium level, amplitude of oscillations, and period of oscillations. For shortest desired inventory coverage, inventory equilibrium level is lowest, amplitude of oscillations is smallest, and period of oscillations is shortest. For longest desired inventory coverage opposite occurs.

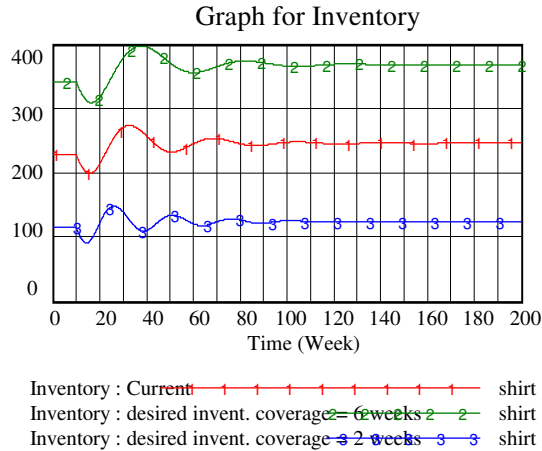


Fig.7. Behavior of Inventory under influence of desired inventory coverage

- **Price Change Delay**

When system is in equilibrium, value of price change delay does not have any effect on price and inventory. Change in price is calculated as the ratio of difference between desired price and current price and price change delay. When system is in equilibrium Price is equal to desired price and difference between them is 0. Therefore, change in price is always 0 despite of value of price change delay.

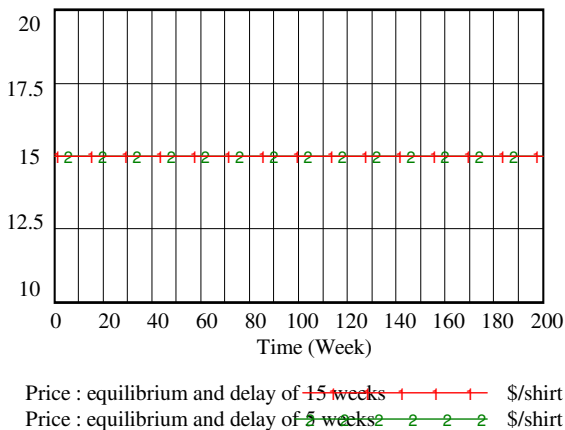


Fig.8. Graph for price when system is in equilibrium

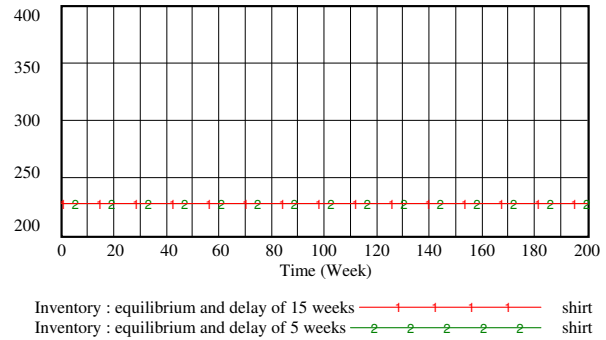


Fig.9. Graph for inventory when system is in equilibrium

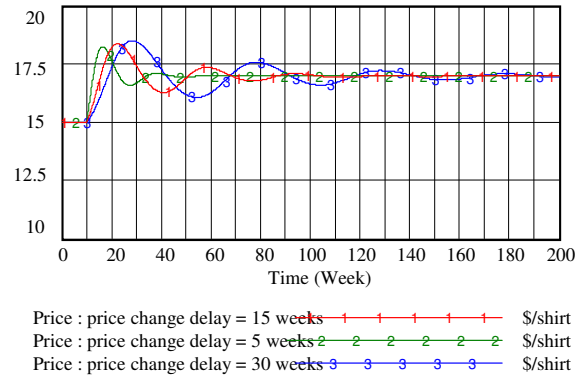


Fig.10. Behavior of price in case of price change delay

One would expect the system to reach equilibrium more quickly when the price change delay is equal to 15 weeks. For example, if current price is \$10 and desired price is \$25, and if price change delay is 15 weeks, after first week price would change for \$1  $((25-10)/15=1)$ . If price change delay is 30 weeks, after first week price would change for \$0.5  $((25-10)/30=0.5)$ . Therefore, when price change delay is shortest, system will reach equilibrium in shortest time, and period of oscillations would be shortest. Opposite happens when price change delay is longest.

- **Damped and sustained oscillations**

In order to generate sustained oscillations, system must be a negative feedback loop and must have at least two stocks. If model has sustained oscillations generic structure with an additional feedback loop damped oscillations occurs. This is what happens in the Economic supply & demand model.

Negative feedback loops 1 and 3 are essential to the behavior of the model. Therefore, I wanted to compare what happens with model behavior if negative feedback loop 2 is removed. According to the graphs of the model behavior, when negative feedback loop 2 is removed (desired inventory is defined as constant and set to 228 shirts) model exhibits sustained oscillations.

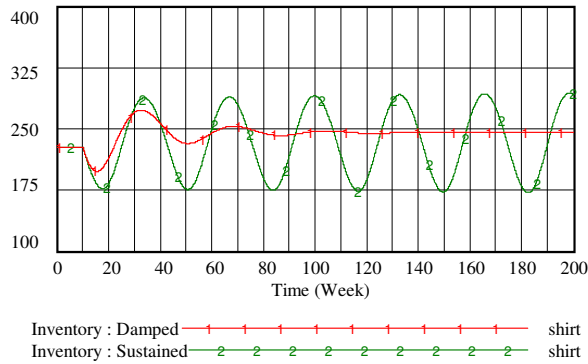


Fig.11. Behavior of Inventory under damped and sustained oscillations

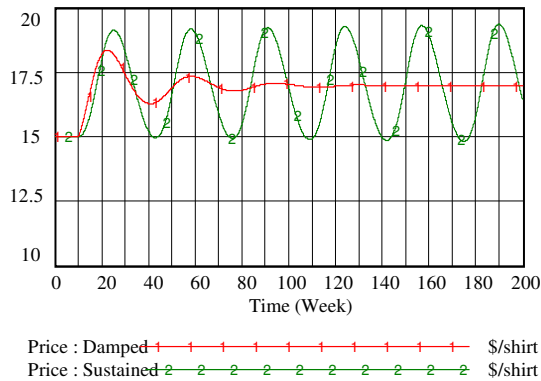


Fig.12. Behavior of Price under damped and sustained oscillations

#### IV. CONCLUSIONS

Management flight simulators are designed in order to initiate active, student-oriented learning which is especially important in entrepreneurship education. Entrepreneurs seek information that is useful in achieving a goal of the game, and during that process their understanding of the system increases. Therefore

management flight simulators could be useful in education of entrepreneurs.

Case study of using supply and demand model in the entrepreneurship class is presented. In addition, many equilibrium models contain feedback loops. For example, when Fed enlarges money supply, interest rates decreases, which in turn decreases costs of investments. Therefore, firms increase investments and people buy more houses. But, savings decrease partly because some is invested and partly because of lower interest rates. Lower savings could in the long run increase interest rates and investments would again decrease. Also, higher money supply could also increase rate of inflation, which also influences investments and savings. In the long run, increase in money supply would only result in higher rate of inflation and production and investments would return to the initial level. It would be interesting to design such model that could be useful in education and analysis of monetary policy.

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